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蝶と蛾 *Trans. lepid. Soc. Japan* **58** (2): 215–237, March 2007

Study on the foodplants of several species of saturniid moths (Lepidoptera, Saturniidae) **in Japan**

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Abstract Most saturniid moths are generalists, and various species of foodplants used by them have been recorded. In Japan, all saturniid moths are large in size, and most larvae feed on the leaves of oak trees (Fagaceae), elm trees (Ulmaceae) and birch trees (Betulaceae), which are forested for the traditional "*Satoyama*" coppice in Japan. It is essential to have an understanding of the roles of Saturniidae in energy flow and the food web in a coppice. However, studies on the biology and community ecology of these moths are limited. We report the foodplants used by these moths in the field, and discuss the relationship between the range of saturniid larvae foodplants (including foodplant species in the literature in Japan) and the genealogy of saturniid moths in Japan. We discovered 44 foodplant species from 19 families utilized by eight species of saturniid moth (*Samia cynthia*, *Antheraea yamamai*, *Saturnia jonasii*, *S. japonica*, *Rhodinia fugax*, *Actias gnoma*, *A. artemis*, and *Aglica japonica*) in our studies. We discovered the larvae of *A. yamamai*, *S. jonasii*, *S. japonica*, *R. fugax* and *A. japonica* feeding on a new foodplant, *C. tschonoskii* (Betulaceae), at most study sites. *R. fugax* utilized the new foodplants *Quercus phillyraeoides* (Fagaceae), *Salix chaenomeloides*, *S. subfragilis* (Salicaceae) and *Benthamidia florida* (Cornaceae), and *S. jonasii* utilized the new foodplants *Q. phillyraeoides* (Fagaceae), *Lindera umbellata* var. *membranacea* (Lauraceae), *Ilex rotunda* (Aquifoliaceae), *Swida macrophylla* (Cornaceae), *Lyonia ovalifolia* (Ericaceae) and *Styrax japonica* (Styracaceae). In similarity tests using the Ochiai index (*OI*) for the foodplant species of saturniid moths, the foodplant species of *S. jonasii* most closely resembled those of *S. japonica* (*OI*=0.417). The foodplant species of *A. yamamai* do not closely resemble those of other species of Saturniidae (*OI*≤0.377). Saturniid moths may avoid overlapping of foodplants. In Euclidean distance analysis, it was shown that *S. japonica* is the remotest species. The geographic distribution of *S. japonica* is wide, so we suggest that the foodplants of *S. japonica* have changed, with the insects adjusting to various species of vegetation that occur over its range. As regards the foodplant habits of saturniid moths, it appears that the foodplant preferences of Saturniidae have become diversified according to local habitat vegetation and to allow them to compete for foodplant resources with other Lepidoptera larvae. *S. japonica*, which lays an egg mass, may shift its preferred foodplant to other surrounding plants in the case of diet shortage caused by overcrowding of larvae. It is suggested that the number of foodplant species increased by oviposition on extra-foodplants and/or by escaping to other plants.

Key words Saturniidae moths, foodplants, genealogy, foodplant preference, foodplant properties.

Introduction

Most Lepidoptera larvae are primary consumers and utilize many species of plant. In Japan, all saturniid moths are large in size, and larvae of these moths feed on leaves of a variety of tree species (Inoue, 1982; Nakajima, 1987). Saturniid moths are distributed widely throughout the world, and, especially in the subtropics, they specialize into many genera and species. In Europe, six species in three genera, in Africa, 206 species in 40 genera, in Asia, 66 species in 40 genera, in Australia, 30 species in five genera, in North America, 39 species in seven genera, and in South America, more than 588 species in 39 genera of Saturniidae are known (Teramoto, 1996). In Japan, 11 native species of Saturniidae in eight genera are distributed, and the life histories of these species have been investigated

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(Hirashima, 1989). The larvae of Saturniidae spin a thick and large cocoon during pupation. Some species of saturniid moths are reared like the silkworm, *Bombyx mori*, to utilize the silk of the cocoon (Teramoto, 1996). In particular, the silk of the Japanese oak moth, *Antheraea yamamai*, cocoon, called "Green Diamond," is very expensive. Recently, these moths have come to play an important role not only in physiological studies such as hormonology, but also in entomological industry, such as cosmetics (Nakatomi, 1993; Kiuchi, 1997). In several countries of Africa and Asia, some species of saturniid larvae and pupae are utilized for food (Tuskes *et al.*, 1996; Kuribayashi, 1998; Matsuka and Umeya, 1998). In particular, many species of saturniid larvae feed on the leaves of oak trees (Fagaceae) and elm trees (Ulmaceae), which are forested for the traditional "Satoyama" coppices in Japan (Shiromoto and Sakuratani, 2004). Some saturniid moths, larvae, pupae and adults are the prey of avian predators such as the carrion crow, *Corvus corone* (Sakuratani, 2001; Shiromoto and Sakuratani, 2004). In recent years, the functions of "Satoyama" have been reconsidered, with the result that their role has been recognized as not only important for production of natural resources but also as a habitat for preserving biodiversity, and coppice management is necessary to maintain these functions (Ishii *et al.*, 1993; Moriyama, 1997). Thus it is essential to clarify the roles of Saturniidae with regard to energy flow and the food web in coppices. However, studies on the biology and community ecology of these moths are limited. As most saturniid moths are generalists, many species of foodplants have been recorded (Kuribayashi, 1990; Teramoto, 2001). For instance, foodplants of *Saturnia japonica* include about 40 tree species and those of *Rhodinia fugax* include about 20 tree species (Inoue, 1982; Miyata, 1983; Japanese Highway Landscape Association, 1984; Sekiguchi, 2003). Field descriptions of foodplants of the Japanese oak moth, *Antheraea yamamai* include 13 tree species, including cherry, *Prunus* × *yedoensis*, and apple, *Malus pumila* (Rosaceae) (Teramoto, 2001). However the foodplants of *P. yedoensis* have not been recorded in the field. Some descriptions of the foodplants of saturniid larvae remain uncertain. Thus it is necessary to review the foodplants of saturniid moths. Moreover, the foodplants used for rearing species such as *A. yamamai* have been described, but field data on the foodplants of other species of saturniid moths remain unclear (Teramoto, 2001).

In this study, we report the foodplants of saturniid moths observed in the field, and discuss the relationship between the hostplant range of saturniid larvae and the genealogy of saturniid moths in Japan.

Methods

We investigated the foodplants of saturniid larvae from 1990 to 2006. The study sites were Naze City (Kagoshima Prefecture), Matsue City (Shimane Prefecture), Kobe City, Takarazuka City and Himeji City (Hyogo Prefecture), Osaka City, Sakai City (Osaka Prefecture), Nara City, Yamatokooriyama City, Ikoma City, Totsukawa-Mura (Nara Prefecture), Kyoto City and Yawata City, Kameoka City (Kyoto Prefecture), Shiga-gun, Kouga-gun (Shiga Prefecture), Nikko City (Tochigi Prefecture), Fukushima City (Fukushima Prefecture), Ishinomaki City (Miyagi Prefecture) (Fig. 1). We recorded the species of saturniid moths, the stage (eggs, larvae and pupae) and the foodplant species at each study site. The cocoons of Saturniidae are usually spun among the leaves of the hostplant, and their eggs are usually laid on the host plant (Inoue, 1982; Tuskes *et al.*, 1996), on these grounds we essentially regarded the species of plant associated with cocoons or eggs as host plant data. The data on foodplant species in this study is shown in Table 1, and Table 2 presents the literature for foodplant data. Cluster analysis (Sakuratani & Natsuhara, 1994) was applied to the foodplants of saturniid moths, through examining the relationship

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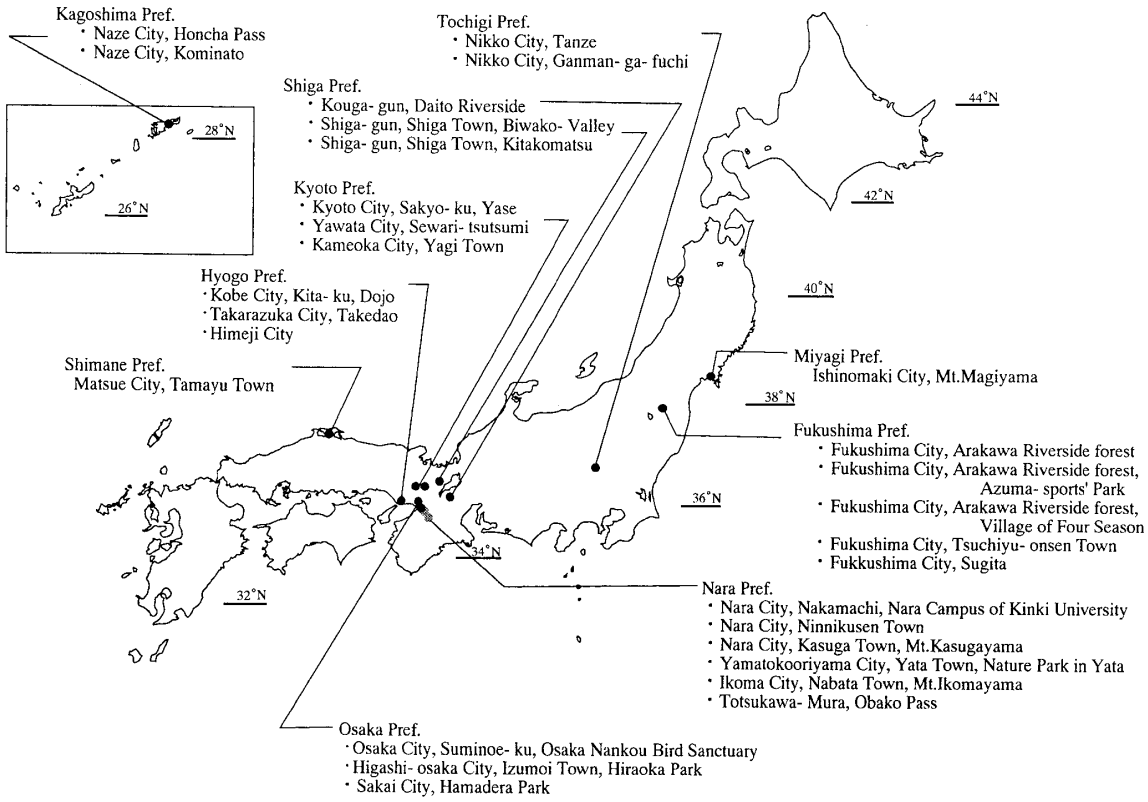

Fig. 1. Study sites.

between the saturniid moth species and the geographic distance. Similarities of the foodplant species of saturniid moths were determined with the Ochiai index (*OI*) (Natsuhara, 1998) to clarify the interspecific relationship of saturniid moth species. *OI* index is as follow;

$$OI = \frac{c}{\sqrt{a}\sqrt{b}}$$

where the numbers of foodplant species of two saturniid moth species are a and b, respectively, and c is the number of foodplant species common to both moth species. Similarities of the foodplant family of saturniid moths were also determined with the Ochiai index (*OI*).

For the arrangement of scientific names, we followed the conventions of *"Moths of Japan"* (Inoue, 1982) for saturniid moths and "*Revised Edition Makino's new illustrated Flora of Japan*" (Makino, 1989) for foodplants.

Results

A. List of foodplants recorded in the current study

The following foodplants of eight saturniid species were recorded in this investigation. New foodplants were recorded for four species of saturniid moths. The arrangement of the data obtained in this study is as follows.

Species of foodplant: locality, date, stage or cocoon (pupa) [number of individuals].

We confirmed that no other foodplants grew nearby, and considered that the plant with the

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cocoon was the foodplant of that saturniid moth.

1. *Samia cynthia* (Japanese name: Shinjusan)

LAURACEAE

Cinnamomum camphora (Japanese name: Kusunoki): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 18-Oct.-2003, cocoon [1].

ROUTACEAE

Zanthoxylum ailanthoides (Japanese name: Karasuzanshou): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 3-Mar.-2005, cocoon (pupa) [1].

EUPHORBIACEAE

Sapium sebiferum (Japanese name: Nankinhaze): Nara Pref.: Nara City, Kasugano Town, Mt Kasuga, 1-Jul.-2004, cocoon [4].

Phellodendron amurense (Japanese name: Kihada): Miyagi Pref.: Ishinomaki City, Mt.Magi-yama, 27-Dec.-2004, cocoon (pupa) [1].

SIMAROUBACEAE

Picrasma quassioides (Japanese name: Nigaki): Fukushima Pref.: Fukushima City, Tsuchiyu-Onsen Town, 26-Dec.-2003, cocoon (pupa) [1].

AQUIFOLIACEAE

Ilex rotunda (Japanese name: Kuroganemochi): Osaka Pref.: Sakai City, Hamadera Park, 29-June-2004, cocoon [3]. Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 26-Sep.-2003, last-instar [1]; 18-Oct.-2003, last-instar [4]; 12-Jul.-2004, last-instar [3]; 29-Sep.-2004, last-instar [15], cocoon (pupa) [9]; 15-Feb.-2005, cocoon (pupa) [1]; 13-Sep.-2005, third-instar [8]. Hyogo Pref.: Himeji City, Hamate-Ryokuchi, 30-Aug.-2005, cocoon [2].

SCROPHULARIACEAE

Paulownia tomentosa (Japanese name: Kiri): Miyagi Pref.: Ishinomaki City, Mt, Magiyama, 27-Dec.-2004, cocoon (pupa) [1].

This species is univoltine in North Japan and bivoltine in Central and South Japan. The overwintering stage is the diapausing pupa in a cocoon. Utilization frequency of *I. rotunda* was high at three places: Hyogo, Nara and Osaka Pref. In Nara City, we found an aggregation of these larvae on *I. rotunda* (Aquifoliaceae), which is planted as a roadside tree every year. The cocoons of this species were collected on *Paulownia tomentosa* (Japanese name: Kiri), *Cinnamomum camphora* (Japanese name: Kusunoki) and *Euscaphis japonica* (Japanese name: Gonzui) (Shiromoto and Sakuratani, 2004). In 2004, this cocoon was found on *Zanthoxylum ailanthoides* (Routaceae). There were records of this larvae feeding on *P. tomentosa* (Scrophulariaceae) in Ishinomaki City (Miyagi Pref.). The larvae of this species usually utilized the compound leaves of *E. japonica*, *P. amurense* and *Z. ailanthoides*, or the leaves of evergreen trees, *C. camphora* and *I. rotunda*.

2. *Antheraea yamamai* (Japanese name: Yamamayu)

MYRICACEAE

Myrica rubra (Japanese name: Yamamomo): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 13-June-2000, [several larvae], 25-June-2001, last-instar [1].

BETULACEAE

Carpinus tschonoskii (Japanese name: Inushide): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 24-May-2004, egg [10], 8-Jnn.-2004, third-instar [1]/Ikoma City, Nabata Town, Mt Ikomayama, 5-Dec.-2004, egg [8]. Hyogo Pref.: Kobe City, Kita-ku, Dojyo, 25-Apr.-2004, second-instar [7], third-instar [1]. Tochigi Pref.: Nikko City, Ganman-ga-fuchi, 2-Jan.-2005, cocoon [9]. Fukushima Pref.: Fukushima City, Arakawa

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Riverside forest, 4-Jul.-2004, last-instar [4]; 29-Dec.-2004, egg [2], cocoon [5]; 30-Dec-2004, egg [8], cocoon [19]; 30-Dec.-2004, egg [26], cocoon [27]; 23-Aug.-2005, cocoon (pupa) [3]; 24-Aug.-2005, cocoon [3]; 2-Jul.-2006, last-instar [1]/ Fukushima City, Village of Four Season, 6-Jul.-2004, last-instar [3]/Fukushima City, Sugita, 31-Dec.-2004, cocoon [2]. Miyagi Pref.: Ishinomaki City, Mt.Magiyama, 27-Dec.-2004, cocoon [5].

Corylus sieboldiana (Japanese name: Tsunohashibami): Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 29-Dec.- 2004, cocoon [3], 2-Jul.-2006, last-instar [1], cocoon [1].

FAGACEAE

Fagus japonica (Japanese name: Inubuna): Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 29-Dec.-2004, cocoon [1]. Miyagi Pref.: Ishinomaki City, Mt. Magiyama, 27-Dec.-2004, cocoon [3].

Quercus serrata (Japanese name: Konara): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 1-Apr.-2002, egg [6]; 30-Jan.-2004, egg [10]; 15-Feb.-2005, egg [11]/Nara City, Ninnikusen Town, 17-June-2004, last-instar [1]; 20-Feb.-2005, cocoon [2]/Yamatokooriyama City, Yata Town, Nature Park in Yata, 12-Aug.-2004, cocoon [1]; 16-Dec.-2004, egg [51], cocoon [2]/Ikoma City, Nabata Town, Mt Ikomayama, 5-Dec.-2004, egg [10]. Shiga Pref.: Shiga Town, Genki Mura, 9-May-2005, fourth-instar [4]; 23-Aug.-2005, cocoon [2]. Tochigi Pref.: Nikko City, Ganman-ga-fuchi, 2-Jan.-2005, cocoon [5]. Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 4-Jul.-2004, last-instar [2]; 5-Jul.-2004, last-instar [4]; 29-Dec.-2004, egg [17], cocoon [12]; 30-Dec.-2004, egg [3], cocoon [7]; 2-Jul.-2006, last-instar [3]/Fukushima City, Village of Four Season, 6-Jul.-2004, last-instar [2]/Fukushima City, Sugita, 31-Dec.-2004, egg [36], cocoon [9]. Miyagi Pref.: Ishinomaki City, Mt.Magiyama, 27-Dec.-2004, cocoon [3].

Quercus acutissima (Japanese name: Kunugi): Kyoto Pref.: Kameoka City, Yagi Town, 4-June-2004, cocoon [1].

Quercus variabilis (Japanese name: Abemaki): Hyogo Pref.: Kobe City, Kita-ku, Dojyo, 25-Apr.-2004, second-instar [2].

Quercus phillyraeoides (Japanese name: Ubamegashi): Nara Pref.: Ikoma City, Nabata Town, Mt Ikomayama, 30-May-2004, third-instar [1]; 5-Dec.-2004, egg [24]/Nara City, Nakamachi, Nara Campus of Kinki University, 1-June-2004, fourth-instar [3]; 2-June-2004, last-instar [1]/Nara City, Ninnikusen Town, 17-June-2004, fourth-instar [3]; 15-Feb.-2004, cocoon [1]. Hyogo Pref.: Kobe City, Kita-ku, Dojyo, 1-June-1993, last-instar [1].

Quercus myrsinaefolia (Japanese name: Shirakashi): Shimane Pref.: Matsue City, Tamayu Town, 8-Nov.-2004, cocoon [1]. Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 15-Feb.-2005, egg [10]. Kyoto Pref.: Kameoka City, Yagi Town, 4-June-2004, cocoon [1].

Quercus glauca (Japanese name: Arakashi): Osaka Pref.: Higashi-Osaka City, Izumoi Town, Hiraoka Park, 5-Dec. 2004, egg [9]/Osaka City, Suminoe-ku, Osaka Nankou, 26-Jan-2006, cocoon [2]. Nara Pref.: Yamatokooriyama City, Yata Town, 16-Dec.-2004, cocoon [1]. Kyoto Pref.: Kameoka City, Yagi Town, 4-June-2004, fourth-instar [1]. Hyogo Pref.: Takarazuka City, Takedao, 25-Apr.-2004, third-instar [13].

Quercus sessilifolia (Japanese name: Tsukubanegashi): Nara Pref.: Nara City, Kasugano Town, Mt Kasugayama, 11-Sep.-2004, cocoon [2].

Castanea crenata (Japanese name: Kuri): Nara Pref.: Ikoma City, Nabata Town, Mt Ikomayama, 5-Dec.-2004, egg [2]/Nara City, Ninnikusen Town, 20-Dec.-2005, cocoon [1]. Shiga Pref.: Ohtsu City, Ishiyama, 11-Jul.-2004, last-instar [1]/Shiga-gun, Shiga Town, Genki Mura, 9-June-2005, third-instar [3]. Tochigi Pref.: Nikko City, Ganman-ga-

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fuchi, 2-Jan.-2005, cocoon [5]. Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 29-Dec. 2004, cocoon [5]; 24-Aug.-2005, cocoon [3]; 2-Jul.-2006, last-instar [1].
Castanopsis sieboldii (Japanese name: Sudajii): Kagoshima Pref.: Naze City, Kominato, 25-May-1996, last instar [1]/Naze City, Honcha Pass, 12-June-2004, last-instar [4]. Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 23-June-1999, last-instar [1]. Kyoto Pref.: Kameoka City, Yagi Town, 4-Jul.-2004, last-instar [5].
Lithocarpus edulis (Japanese name: Matebashii): Osaka Pref.: Osaka City, Suminoe-ku, Osaka Nankou Bird Sanctuary, 16-Dec.-1993, cocoon [1]; 14-Dec.-1994, cocoon [1]; 3-Jul.-2004, last-instar [1]. Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 16-Dec.-2003, cocoon [1].

ROSACEAE

Prunus × *yedoensis* (Japanese name: Someiyoshino): Kyoto Pref.: Kyoto City, Sakyo-ku, Yase, 13-Aug.-2004, egg [16].
Prunus jamasakura (Japanese name: Yamazakura): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 31-Mar.-2003, egg [18]. Tochigi Pref.: Nikko City, Ganman-ga-fuchi, 2-Jan.-2005, cocoon [1].

This species is polyphagous and univoltine in Japan. The hibernation stage is early-instar larva in the egg shell. *Q. serrata* was utilized most in many areas. *C. tschonoskiii* was the dominant species and hitherto has not been recorded. In Nara, Hyogo, Fukushima and Miyagi Prefectures, eggs and the larvae (first and last instar) were found on *C. tschonoskii* (Betulaceae) and they may commonly feed on this plant in Japan. The frequency of utilization of *Q. acutissima* and *Q. crenata* were low. In Nara Prefecture, we know that the larvae feed on several species of oak tree; *Q. serrata*, *Q. acutissima*, *Q. glauca*, *Q. phillyraeoides*, *Castanopsis sieboldii*, and *Lithocarpus edulis*. In June 2001, the larvae and cocoons were collected on *Myrica rubra* planted as garden plants (Shiromoto and Sakuratani, 2004). On Amami Island, larvae fed only on *C. sieboldi*.

3. *Saturnia jonasii* (Japanese name: Himeyamamayu)

BETULACEAE

Carpinus tschonoskii (Japanese name: Inushide): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 8-June-2004, third-instar [1]. Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 2-Jul.-2006, last-instar [2].

FAGACEAE

Quercus phillyraeoides (Japanese name: Ubamegashi): Nara Pref.: Ikoma City, Nabata Town, Mt Ikomayama, 30-May-2004, last-instar [1].
Quercus serrata (Japanese name: Konara): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 19-Apr.-2003, first-instar [1].
Castanea crenata (Japanese name: Kuri): Nara Pref.: Ikoma City, Nabata Town, Mt Ikomayama, 30-May-2004, last-instar [1].

LAURACEAE

Lindera umbellata var. *membranacea* (Japanese name: Obakuromoji): Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 5-Jul.- 2004, last-instar [1].

ROSACEAE

Prunus × *yedoensis* (Japanese name: Someiyoshino): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 19-May-2003, fourth-instar [1], last-instar [1]; 21-Apr.-2005, first-instar [1].
Prunus jamasakura (Japanese name: Yamazakura): Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 2-Jul.-2006, last-instar [1].

ACERACEAE

Acer mono var. marmoratum f. *dissectum* (Japanese name: Itayakaede): Shiga Pref.:

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Shiga-gun, Shiga Town, Biwako-Valley, 17-Jul.-2005, last-instar [1]. Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 5-Jul.-2004, last-instar [1].

AQUIFOLIACEAE

Ilex rotunda (Japanese name: Kuroganemochi): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 1-June-2000, last-instar [1]; 18-June-2000, last-instar [1].

CORNASEAE

Swida macrophylla (Japanese name: Kumanomizuki): Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 2-Jul.-2006, last-instar [1].

ERICACEAE

Lyonia ovalifolia (Japanese name: Nejiki): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 18-Apr.-2005, first-instar [1]; 21-Apr.-2005, first-instar [1].

STYRACACEAE

Styrax japonica (Japanese name: Egonoki): Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 2-Jul.-2006, last-instar [2].

This species is polyphagous and univoltine in Japan. The overwintering stage is the egg. Foodplants from various families were utilized in every area. In Nara Prefecture, the foodplants are cherry tree *P. yedoensis* (Rosaceae), *V. dilatatum* (Caprifoloaceae), *I. rotunda* (Aquifoliaceae) and other trees. Fourth-instar larvae were found on the foodplants, *C. tschonoskii* and *Q. phillyraeoidesi*, in 2004, and first-instar larvae were found feeding on *L. ovalifolia* (Ericaceae) in 2005. We found last-instar larvae feeding on *L. umbellata* (Lauraceae) in Fukushima Prefecture.

4. *Saturnia japonica* (Japanese name: Kususan)

JUGLANDACEAE

Juglans mandshurica var. *sachalinensis* (Japanese name: Onigurumi): Hyogo Pref.: Kobe City, Kita-ku, Dojo, 25-Apr.-2004, egg [18]. Fukushima Pref.: Fukushima City, Tsuchiyu-Onsen Town, 6-Jul.-2004, last-instar [1]; 2-Jul.-2006, last-instar [4].

BETULACEAE

Carpinus japonica (Japanese name: Kumashide): Fukushima Pref.: Fukushima City, Tsuchiyu-Onsen Town, 6-Jul.-2004, last-instar [1].

Carpinus tschonoskii (Japanese name: Inushide): Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 4-Jul.-2004, last-instar [1], cocoon [5]; 29-Dec.-2004, egg [142], cocoon [1]; 24-Aug.-2005, cocoon [1]; 2-Jul.-2006, last-instar [3].

FAGACEAE

Quercus serrata (Japanese name: Konara): Fukushima Pref.: Fukushima City, Tsuchiyu-Onsen Town, 6-Jul.-2004, last-instar [1], cocoon [1]/Fukushima City, Arakawa Riverside forest, 29-Dec.-2004, cocoon [1]; 23-Aug.-2005, cocoon [5]; 2-Jul.-2006, cocoon [1]/Fukushima City, Arakawa Riverside forest Azuma-sports' Park, 24-Aug.-2005, cocoon [1].

Castanea crenata (Japanese name: Kuri): Nara Pref.: Nara City, Ninnikusen Town, 17-June-2004, last-instar [6]. Hyogo Pref.: Kobe City, Kita-ku, Dojo, 25-Apr.-2004, egg [10]. Kyoto Pref.: Kameoka City, Yagi Town, 4-June-2004, last-instar [several larvae]. Shiga Pref.: Shiga-gun, Shiga Town, Genki Mura, 29-May-2005, cocoon (pupa) [1]. Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 5-Jul.-2004, last-instar [18]; 29-Dec.-2004, cocoon [1]; 23-Aug.-2005, cocoon [1]/Fukushima City, Tsuchiyu-Onsen Town, 6-Jul.-2004, last-instar [about 30], cocoon (pupa) [1]/Fukushima City, Arakawa Riverside forest Azuma-sports' Park, 24-Aug.-2005, cocoon (pupa) [7]; 2-Jul.-2006, last-instar [102].

ROSACEAE

Prunus grayama (Japanese name: Uwamizuzakura): Fukushima Pref.: Fukushima City,

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Arakawa Riverside forest, 23-Aug.-2005, cocoon [1]; 24-Aug.-2005, cocoon [1]; 23-Feb.-2006, egg [78], cocoon [1]; 2-Jul.-2006, last-instar [2].

Prunus jamasakura (Japanese name: Yamazakura): Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 2-Jul.-2006, last-instar [6].

ANACARDIACEAE

Rhus javanica var. *roxburghii* (Japanese name: Nurude): Nara Pref.: Nara City, Ninnikusen Town, 17-June-2004, last-instar [1]; 20-Feb.-2005, cocoon [1]. Kyoto Pref.: Kameoka City, Yagi Town, 4-June-2004, last-instar [13]. Hyogo Pref.: Kobe City, Kita-ku, Dojo 25-Apr.-2004, egg [8], cocoon [2]. Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 4-Jul.-2004, cocoon [1]; 5-Jul.-2004, cocoon [1]; 2-Jul.-2006, last-instar [28].

ACERACEAE

Acer mono var. *marmoratum* f. *dissectum* (Japanese name: Itayakaede): Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 2-Jul.-2006, last-instar [20].

HIPPOCASTANACEAE

Aesculus hippocastanum (Japanese name: Seiyotochinoki): Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 2-Jul.-2006, last-instar [2].

CORNASEAE

Swida macrophylla (Kumanomizuki): Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 2-Jul.-2006, last-instar [25].

This species is polyphagous and univoltine in Japan. The overwintering stage is the egg. These larvae are well-known pests of plantations such as chestnut and walnut, and they are gregarious (Sekiguchi, 2003). *C. crenata* and *R. javanica* var. *roxburghii* were utilized in many areas. We found the gregarious larvae on *R. javanica* var. *roxburghii* in the Arakawa River (Fukushima Pref.) and in a chestnut *C. crenata* plantation in Yagi (Kyoto Pref.). Many larvae and cocoons of this species were found on *C. tschonoskii* in the Arakawa Riverside forest. However, we have not found these gregarious larvae in the coppice on Nara Campus of Kinki University (Nara Pref.) and the species is rare (Shiromoto & Sakuratani, 2004).

5. *Rhodinia fugax* (Japanese name: Usutabiga)

SALICACEAE

Salix chaenomeloides (Japanese name: Marubayanagi): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 8-June-2005, fourth-instar [1].

Salix subfragilis (Japanese name: Tachiyanagi): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 15-Apr.-2004, first-instar [7].

BETULACEAE

Carpinus tschonoskii (Japanese name: Inushide): Hyogo Pref.: Kobe City, Kita-ku, Dojo, 25-Apr.-2004, second-instar [1]. Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 5-Jul. 2004, last-instar [1]; 5-Jul.-2004, last-instar [1]; 4-Jul.-2004, cocoon [1]; 30-Dec.-2004, cocoon [1]; 30-Dec.-2004, cocoon [2]; 2-Jul.-2006, last-instar [3].

FAGACEAE

Quercus phillyraeoides (Japanese name: Ubamegashi): Nara Pref.: Ikoma City, Nabata Town, Mt Ikomayama, 30-May-2004, last-instar [3]; 10-Jul.-2005, cocoon (pupa) [1].

Quercus acutissima (Japanese name: Kunugi): Nara Pref.: Yamatokooriyama City, Nature Park in Yata, 16-Dec.-16, cocoon [1].

Quercus serrata (Japanese name: Konara): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 5-Jan.-2004, cocoon [1]; 16-Apr.-2005, first-instar [4]/Nara City, Ninnikusen Town, 20-Feb.-2005, cocoon [1]/Yamatokooriyama City, Yata Town, Nature Park in Yata, 23-Jan.-2004, cocoon [1]/Ikoma City, Nabata Town, Mt Ikomayama,

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5-Dec.-2004, egg [1], cocoon [2].

Quercus myrsinaefolia (Japanese name: Shirakashi): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 5-Jul.-2005, cocoon [1].

Castanea crenata (Japanese name: Kuri): Nara Pref.: Ikoma City, Nabata Town, Mt Ikomayama, 30-May-2004, last-instar [1]; 5-Dec.-2004, egg [12], cocoon [2]; 10-Jul.-2005, last-instar [2], cocoon (pupa) [2]/Nara City, Ninnikusen Town, 20-Feb.-2005, cocoon [1]. Shiga Pref.: Shiga-gun, Shiga Town, Genki Mura, 29-May-2005, fourth-instar [2], cocoon (pupa) [1]. Tochigi Pref.: Nikko City, Tanze, 2-Jan.-2005, egg [4], cocoon [2]. Fukushima Pref.: Fukushima City, Village of Four Season, 30-Dec.-2004, egg [3].

ULMACEAE

Celtis sinesis var. *japonica* (Japanese name: Enoki): Nara Pref.: Ikoma City, Nabata Town, Mt Ikomayama, 5-Dec.-2004, cocoon [5].

Zelkova serrata (Japanese name: Keyaki): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 4-June-2004, last-instar [1]; 29-Nov.-2004, cocoon [7]; 16-Apr.-2005, egg [4]/Ikoma City, Nabata Town, Mt Ikomayama, 5-Dec.-2004, egg [3], cocoon [1]/Yamatokooriyama City, Yata Town, Nature Park in Yata, 16-Dec.-2004,cocoon [3]. Tochigi Pref.: Nikko City, Ganman-ga-fuchi, 2-Jan.-2005, cocoon [1]. Miyagi Pref.: Ishinomaki City, Mt.Magiyama, 27-Dec.-2004, cocoon [2].

Ulmus davidiana var. japonica (Japanese name: Harunire): Tochigi Pref.: Nikko City, Nikko, 2-Jan.-2005, cocoon [1].

ROSACEAE

Prunus mume (Japanese name: Ume): Nara Pref.: Yamato-Koriyama City, Yata Town, Nature Park in Yata Hills, 16-Dec.-2004, cocoon [1].

Prunus grayama (Japanese name: Uwamizuzakura): Nara Pref.: Ikoma City, Nabata Town, Mt Ikomayama, 5-Dec.-2004, cocoon [2].

Prunus × *yedoensis* (Japanese name: Someiyoshino): Nara Pref.: Yamato-Koriyama City, Yata Town, Nature Park in Yata, 16-Dec.-2004, cocoon [2]/Ikoma City, Nabata Town, Mt Ikomayama, 5-Dec.-2004, egg [17], cocoon [1]; 10-Jul.-2005, last-instar [1]/Nara City, Nakamachi, Nara Campus of Kinki University, 7-June-2005, last-instar [1]. Kyoto Pref.: Yawata City, Sewari-tsutsumi, 9-Dec.-2004, cocoon [1]; 23 Dec.-2004, egg [7], cocoon [4].

Prunus jamasakura (Japanese name: Yamazakura): Miyagi Pref.: Ishinomaki City, Mt.Magiyama, 27-Dec.-2004, egg [6], cocoon [3].

ACERACEAE

Acer palmatum (Japanese name: Irohamomiji): Nara Pref.: Ikoma City, Nabata Town, Mt Ikomayama, 5-Dec.-2004, cocoon [9]; 10-Jul.-2005, last-instar [1]. Kyoto Pref.: Kameoka City, Yagi Town, 4-June-2004, last-instar [3], cocoon [1]/Kyoto City, Sakyo-ku, Yase, 7-Sep.-2004, cocoon [1]. Tochigi Pref.: Nikko City, Ganman-ga-fuchi, 2-Jan.-2005, cocoon [1]. Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 29-Dec.-2004, cocoon [1]. Miyagi Pref.: Ishinomaki City, Mt.Magiyama, 27-Dec.-2004, cocoon [1].

CORNACEAE

Benthamidia florida (Japanese name: Hanamizuki): Kyoto Pref.: Yawata City, Sewari-tsutsumi, 9-Dec.-2004, cocoon [4], egg [9].

This species is polyphagous and univoltine in Japan. The hibernation stage is the egg. Adults emerge latest among saturniid species. *A. palmatum* planted as a garden plant was utilized in many areas. We found larvae on new foodplants, *Salix subfragilis* (Salicaceae), in 2004, *S. chaenomeloides* in 2005 on the Nara Campus of Kinki University (Nara City) and *C. tschonoskii* in 2004 in Hyogo Prefecture and Fukushima Prefecture. In Kyoto Prefecture, the cocoon and the eggs were found on *B. florida* planted as garden plants in

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2004.

6. *Actias gnoma* (Japanese name: Onagamizuao)

BETULACEAE

Alnus firma (Japanese name: Yashabushi): Shiga Pref.: Shiga-gun, Shiga Town, Kitakomatsu, 1-Sep.-2004, egg [4].

Alnus japonica (Japanese name: Hannoki): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 11-May-2004, first-instar [10]/Nara City, Ninnikusen Town, 30-May-2005, egg [4].

This species is oligophagous, feeding on fewer foodplants than other saturniid moths. The morphology and life cycle of this species are very similar to those of *A. artemis*. We did not find larvae of this species on plants other than *A. japonica* in this study.

While plants of the genus *Alnus* are known host plants, we did not find them feeding on A. sieboldiana growing near *A. japonica* on the Nara Campus of Kinki University (Nara City).

7. *Actias artemis* (Japanese name: Omizuao)

BETULACEAE

Alnus sieboldiana (Japanese name: Obayashabushi): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 2-Aug.-2003, fourth-instar [5]; 1-Jul.-2004, egg [16]. Shiga Pref.: Shiga-gun, Shiga Town, Genki Mura, 1-Sep.-2004, egg [32], third-instar [1].

Alnus firma (Japanese name: Yashabushi): Shiga Pref.: Shiga-gun, Shiga Town, Genki Mura, 21-Aug.-2004, egg [8].

Alnus japonica (Japanese name: Hannoki): Nara Pref.: Nara City, Nakamachi, Nara Campus of Kinki University, 3-Aug.-2003, egg [5]; 14-Jul.-2004, egg [1]; larvae [several].

Alnus serrulatoides (Japanese name: Kawaeahannoki): Shiga Pref.: Kouga-gun, Daito Riverside, 11-Oct.-1987, last-instar [1].

*Carpinus tschonoski*i (Japanese name: Inushide): Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 4-Jul.-2004, egg [2].

ACERACEAE

Acer mono var. *marmoratum* f. dissectum (Japanese name: Itayakaede): Nara Pref.: Totsukawa-Mura, Obako Pass, 18-Aug.-2005, last-instar [1].

This species is polyphagous and bivoltine in Japan. The first generation pupa of this species spins a cocoon among the leaves of the foodplant. The second generation pupa spins a cocoon in fallen leaves near the base of the foodplants and hibernates as a pupa. On the Nara Campus of Kinki University (Nara City), the larvae of this species were found on *A. japonica* and *A. sieboldiana* every year. We found eggs on the leaves of *C. tschonoskii* in the Arakawa River (Fukushima Pref.). The parasitic wasp, *Pseudanastatus albitarsis*, appeared from these eggs, therefore we could not identify the larvae feeding on *C. tschonoskii*.

8. *Aglica japonica* (Japanese name: Ezoyotsume)

BETULACEAE

Carpinus tschonoskii (Japanese name: Inushide): Fukushima Pref.: Fukushima City, Arakawa Riverside forest, 2-Jul.-2006, fourth-instar [1], last-instar [2].

FAGACEAE

Quercus serrata (Japanese name: Konara): Kyoto Pref.: Kameoka City, Yagi Town, 3-June-2004, last-instar [1].

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Table 1. List of foodplants of Saturniidae recorded in this study.

Food plants		Species of Saturniidae moths								
Scientific name	Japanese name	*Samia cynthia*	*Antheraea yamamai*	*Saturnia jonasii*	*Saturnia japonica*	*Rhodinia fugax*	*Actias gnoma*	*Actias artemis*	*Aglica japonica*
Myrica rubra	ヤマモモ		●						
Juglans mandshuica var. sachalinensis	オニグルミ				●				
Salix chaenomeloides	マルバヤナギ					●			
S. subfragilis	タチヤナギ					●			
Alnus sieboldiana	オオバヤシャブシ							●	
A. firma	ヤシャブシ						△	△	
A. japonica	ハンノキ						●	●	
A. serrulatoides	カワラハンノキ							●	
Caprinus japonica	クマシデ				●				
C. tschonoskii	イヌシデ		●	●	●	●		△	●
Corylus sieboldiana	ツノハシバミ		●						
Fagus japonica	イヌブナ		○						
Quercus phillyraeoides	ウバメガシ		●	●		●			
Q. acutissima	クヌギ		○			○			
Q. variabilis	アベマキ		●						
Q. serrata	コナラ		●	●	●	●			●
Q. sessilifolia	ツクバネガシ		○						
Q. glauca	アラカシ		●						
Q. myrsinaefolia	シラカシ		○△			○			
Castanea crenata	クリ		●	●	●	●			
Castanopsis sieboldii	スダジイ		●						
Lithocarpus edulis	マテバシイ		●						
Celtis sinensis var. *japonica*	エノキ					○			
Zelkova serrata	ケヤキ					●			
Ulmus davidiana var. *japonica*	ハルニレ					○			
Lindera umbellata var. membranacea	オオバクロモジ			●					
Prunus mume	ウメ					○			
P. grayama	ウワミズザクラ				●	○			
P. yedoensis	ソメイヨシノ		△	●		●			
P. jamasakura	ヤマザクラ		○△	●	●	○△			
Sapium sebiferum	ナンキンハゼ	○							
Zanthoxylum ailanthoides	カラスザンショウ	○							
Phellodendron amurense	キハダ	○							
Picrasma quassioides	ニガキ	○							
Rhus javanica var. *roxburghii*	ヌルデ				●				
Acer palmatum	イロハモミジ					●			
A. mono var. marmoratum f. *dissectum*	イタヤカエデ			●	●			●	
Aesculus hippocastanum	セイヨウトチノキ				●				
Ilex rotunda	クロガネモチ	●		●					
Swida macrophylla	クマノミズキ			●	●				
Benthamidia florida	ハナミズキ					○△			
Lyonia ovalifolia	ネジキ			●					
Styrax japonica	エゴノキ			●					
Paulownia tomentosa	キリ	○							
	Total no. species	6	17	12	11	17	2	6	2

●: Reliable species. Larvae observed feeding on tree in this study.
○: Indefinite species. Cocoon attached to tree from which an adult emerged.
△: Indefinite species. Live egg attached to tree.

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Table 2. Summarized list of foodplants of Saturniidae from the literature and recorded in this study.

Foodplant		Saturniidae							
Family Species (scientific name)	(Japanese name)	*Samia cynthia*	*Antheraea yamamai*	*Saturnia jonasii*	*Saturnia japonica*	*Rhodinia fugax*	*Actias gnoma*	*Actias artemis*	*Aglica japonica*
Ginkgoaceae									
Ginkgo biloba	イチョウ				● 1,2,4,5,7–9				
Myricaceae									
Myrica rubra	ヤマモモ		◎ ○ 6						
Juglandaceae									
Juglandaceae	クルミ類	● 1		● 1,3	● 1,3,7,8				
Juglans mandshuica var. *sachalinensis*	オニグルミ	● 4	△ 6		◎● 4				
J. regia var. *orientalis*	テウチグルミ							● 12	
Salicaceae									
Salicaceae	ヤナギ類			● 3	● 3				
Populus maximowiczii	ドロヤナギ				● 1,2,4,7				
P. nigra var. italica	セイヨウハコヤナギ				● 4				
Salix chaenomeloides	マルバヤナギ					◎			
S. subfragilis	タチヤナギ					◎			
S. bakko	バッコヤナギ	● 4							
S. babylonica	シダレヤナギ		△ 6						
S. kinuyanagi	キヌヤナギ		○ 6						
Betulaceae									
Betulaceae	カバノキ類					● 3		● 1–5,7	● 1,3,5,10
Betula platyphylla var. *japonica*	シラカンバ		○ 6				● 3		● 4,10
Alnus spp.	ハンノキ類						● 3		
A. japonica	ハンノキ				● 1,7	◎● 3,4	◎● 1,2,4,7	● 1,3,5,10	
A. hirsute	ヤマハンノキ							● 9	
A. serrulatoides	カワラハンノキ						● 4	◎	
A. firma	ヤシャブシ		○ 6				◎? ● 3	◎?	● 4,10
A. sieboldiana	オオバヤシャブシ							◎	
Caprinus tschonoskii	イヌシデ		◎ ○ 6	◎	◎	◎		◎?	◎
C. laxiflora	アカシデ		○ 6	● 1					
C. japonica	クマシデ		○ 6		◎				
C. cordata	サワシバ		○ 6						
Corylus sieboldiana	ツノハシバミ		◎						
Fagaceae									
Fagaceae	ブナ類		● 3	● 3,5	● 3	● 3		● 3,5	● 3
Fagus crenta	ブナ		△ 6	● 7					● 1,4,5,10
F. japonica	イヌブナ		◎● 6						
Castanea crenata	クリ		◎● 1–9	◎● 1,7	◎● 1–5,7–9	◎● 1,7		● 1,2,4,7	● 1,5,10
C. mollissima	イタグリ		△ 6						
C. henryi	シイグリ		△ 6						

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Quercus serrata	コナラ		◎●[1–7,9]	◎●[4]	◎●[1,2,4,7,9]	◎●[1,2,4,7]	●[1,2,7,9]	◎●[1,4,5,10]
Q. crispula	ミズナラ		●[6]	●[4]	●[1]			●[4,10]
Q. acutissima	クヌギ	●[3]	◎●[1–7,9]	●[1,2,4,7,9]	●[1,2,4,7,9]	◎●[1–4,7]		●[4]
Q. variabilis	アベマキ		◎●[6]					
Q. aliena	ナラガシワ		●[6]					
Q. dentata	カシワ		●[1–7]	●[14]	●[1]	●[1,7]		●[1,4,5,10]
Q. sp.	カシ		●[1]					
Q. phillyraeoides	ウバメガシ		◎●[6]	◎		◎		●[10]
Q. myrsinaefolia	シラカシ		◎●[6]			◎		
Q. glauca	アラカシ		◎●[4,6]					
Q. acuta	アカガシ		○[6]					
Q. sessilifolia	ツクバネガシ		◎					
Q. salicina	ウラジロガシ		◎					
Q. gilva	イチイガシ		△[6]					
C. sieboldii	スダジイ		◎●[1,6]			●[1]		
Lithocarpus edulis	マテバシイ		◎●[6]					
Ulmaceae								
Ulmaceae	ニレ類			●[3]	●[3]	●[3]		
Ulmus davidiana var. japonica	ハルニレ			●[4]		◎?		●[4,10]
Aphonante aspera	ムクノキ		△[6]					
Zelkova serrata	ケヤキ		△[6]	●[1]	●[1,2,4,7]	◎●[1,2,4,5,7]		
Celtis sinensis var. japonica	エノキ	●[1]			●[1]	◎●[1,7]		
Lauraceae								
Cinnamomum camphora	クスノキ	●[1,3–5]			●[1,8,9]			
Lindera umbellata var. *membranacea*	オオバクロモジ			◎				
Cercidiphyllaceae								
Cercidiphyllum japonica	カツラ				●[2,4,7,9]			
Platanaceae								
Platanus orientalis	スズカケノキ				●[1]			
Hamamelidaceae								
Liquidamber fomosana	フウ		△[6]					
L. styracifl	アメリカフウ		●?○[6]					
Saxifragaceae								
Deutzia crenata	ウツギ			●[1,2,4,7]				
Rosaceae								
Rosaceae	バラ科植物			●[3,5]			●[3,5]	
Malus domestica	リンゴ	●[1,4]	●[2–7]	●[7,8]	●[1,2,4,7,8]		●[1,2,4,7]	
M. prunifolia	ヒメリンゴ	△[6]						
Pyrus pyrifolia var. culta	ナシ	●[1,4]		●[1,2,4,7]	●[1,2,4,7]		●[1,4,7]	
Sorbus commixta	ナナカマド							●[4,10]
Pourthiaea villosa	カマツカ		●[6]				●[2,4,7]	
Chaenomeles sinensis	カリン		△[6]					
Prunus armeniaca	アンズ		○[6]		●[7]		●[2,4,7]	

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P. mume	ウメ			●[1,2,4,7,8]	●[1,2,4,7–9]	◎		●[2,4,7–9]	
P. salicina	スモモ		△[6]	●[2,4,7]	●[1,2,4,7]				
P. persica	モモ				●[2,4,7]				
P. spp.	サクラ類	●[2–5,7–9]		●[1,2,7–9]	●[1]	●[1–3,5,7]			
P. yedoensis	ソメイヨシノ	◎?		◎●[4]		◎●[4]			
P. jamasakura	ヤマザクラ	◎	△[6]	◎	◎	◎			
P. grayama	ウワミズザクラ				◎	◎			
Euphorbiaceae									
Mallotus philippensis	アカメガシワ				●[1]				
Sapium sebiferum	ナンキンハゼ	◎?●[1,3,4]							
Routaceae									
Routaceae	柑橘類	●[1]							
Zanthoxylum armatum	フユザンショウ	●[4]							
Zanthoxylum ailanthoides	カラスザンショウ	◎●[4]							
Euodia meliifolia	ハマセンダン	●[4]							
Phellodendron amurense	キハダ	◎●[1–3,5]					●[1]		
Simaroubaceae									
Picrasma quassioides	ニガキ	◎●[1–5]							
Ailanthus sltissima	シンジュ (ニワウルシ)	●[1–5]							
Anacardiaceae									
Rhus succedanea	ハゼノキ				●[1,2,7–9]				
R. silvestris	ヤマハゼ				●[4]				
R. verniciflua	ウルシ				●[1,7,8]				
R. javanica var. roxburghii	ヌルデ	●[1,4]				◎●[1–4,7]			
Aceraceae									
Aceraceae	カエデ類			●[2,3,5,7,8]	●[7,8]	●[1,3,5,7,8]		●[1,2,7–9]	●[3,10]
Acer palmatum	イロハモミジ	△[6]		●[1]		◎			
A. amoenum	オオモミジ					●[4]		●[4]	
A. japonicum	ハウチワカエデ								●[4,10]
A. tschonoskii	ミネカエデ								●[4,10]
A. nipponicum	テツカエデ			●[4]					
A. mono var. marmoratum f. *dissectum*	イタヤカエデ			◎●[1]	◎			◎	
Hippocastanaceae									
Aesculus hippocastanum	セイヨウトチノキ				◎				
Aquifoliaceae									
Ilex rotunda	クロガネモチ	◎●[4]			◎				
Staphyleceae									
Euscaphis japonica	ゴンズイ	●[1–4,11]							
Rhamnaceae									
Rhamnella franguloides var. *inaequilatera*	ヤエヤマネコノチチ	●[4]							
Tiliaceae									
Tilia maximowicziana	オオバボダイジュ								●[4,10]
Sterculiaceae									

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Firmiana simplex	アオギリ	● 1							
Lythraceae									
Lagerstroemia indica	サルスベリ				● 1,4,7,8				
Punicaceae									
Punica granatum	ザクロ				● 7,8			● 2,7	
Cornaceae									
Cornaceae	ミズキ類			● 3,5				● 3	
Swida controversa	ミズキ			● 1,2,4,7		● 7			
S. macrophylla	クマノミズキ			◎	◎ ● 4				
Benthamidia florida	ハナミズキ				◎				
Araliaceae									
Schefflera octophylla	フカノキ								● 10
Kalopanax pictus	ハリギリ			● 4					
Ericaceae									
Pieris japonica	アセビ							● 1,2,4,7,9	
Lyonia ovalifolia	ネジキ			◎					
Ebenaceae									
Diospyros kaki	カキノキ				● 1,2,4,7–9				
Styraceae									
Styrax japonica	エゴノキ	● 1,3,5		◎					
Oleaceae									
Osmanthus sp.	モクセイ	● 1							
Fraxinus sp.	シマトネリコ	● 13							
Ligustrum japonicum	ネズミモチ	● 1,4							
Verbernaceae									
Clerodendron trichotomum	クサギ	● 1,4,9							
Scrophulariaceae									
Paulownia tomentosa	キリ	● 1,11							
Caprifoliaceae									
Caprifoliaceae	スイカズラ類			● 5					
Viburnum dilatatum	ガマズミ			● 1,2,4,7,911					
V. odoratissimum var. *awabuki*	サンゴジュ			● 2,4,7,8					
Lonicera japonica	スイカズラ			● 7					
Palmae									
Trachycarpus fortunei	シュロ	● 4							
	Total no. species	24	30	31	35	23	4	16	17

◎ : Field data in this study. ●: Field data by literature. ○: Rearing data by literature. △: Some of the larvae matured in rearing. ?: Species needs to be reconfirmed.
Total no. species: Total number of foodplant species except △, ◎?, Foodplant name is sp.
1: Esaki (1958), 2: Hattori (1965), 3: Nakajima (1987), 4: Miyata (1983), 5: Inoue (1982), 6: Teramoto (2001), 7: Sekiguchi (2003), 8: The Japanese Society of Applied Entomology and Zoology (1987), 9: Japanese Highway Landscape Association (1984), 10: Ohno (2002); 11: Shiromoto and Sakuratani (2004), 12: Kanai (2002), 13: Azuma (1996), 14: Kogi (2005)

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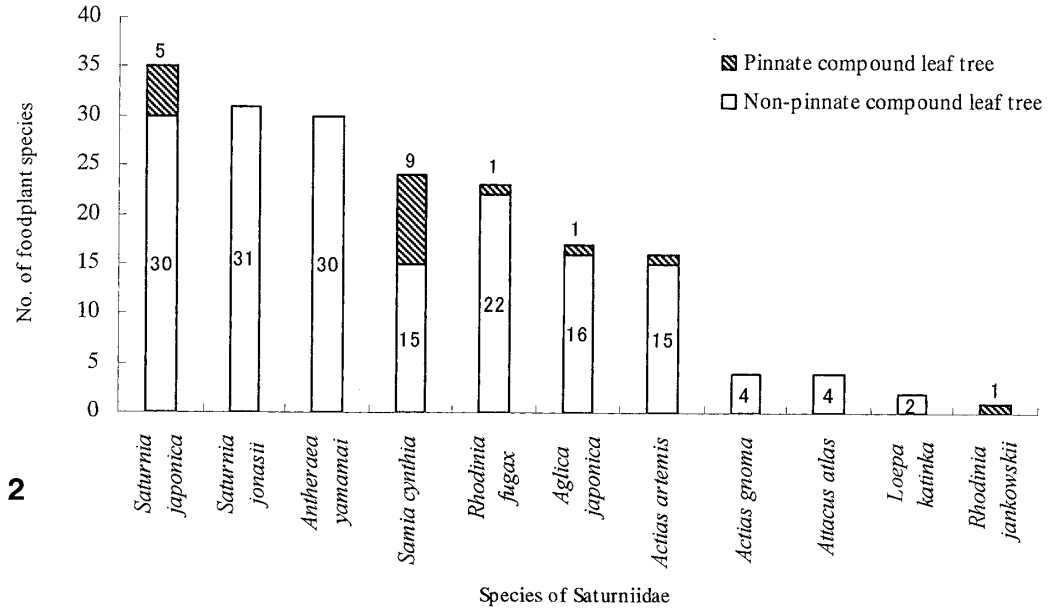
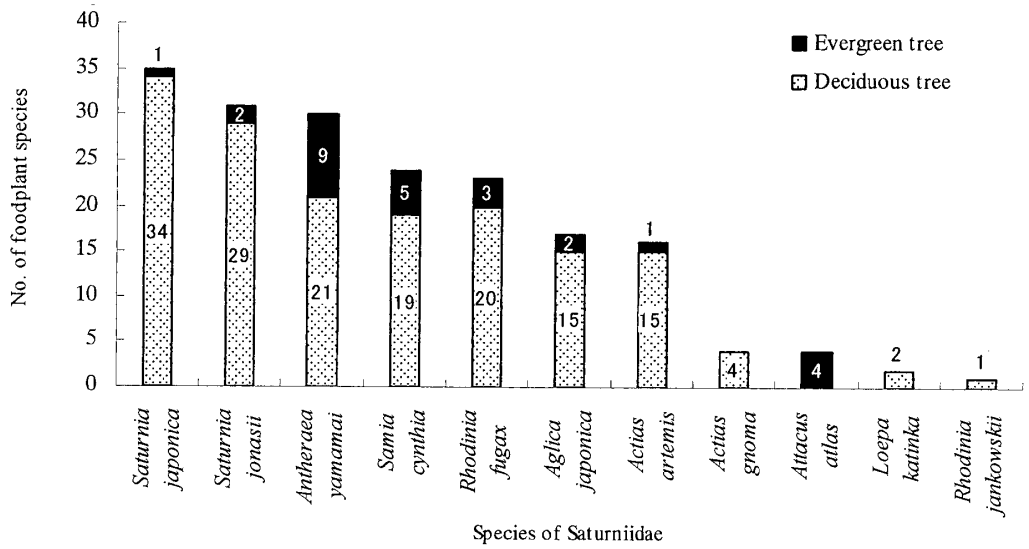
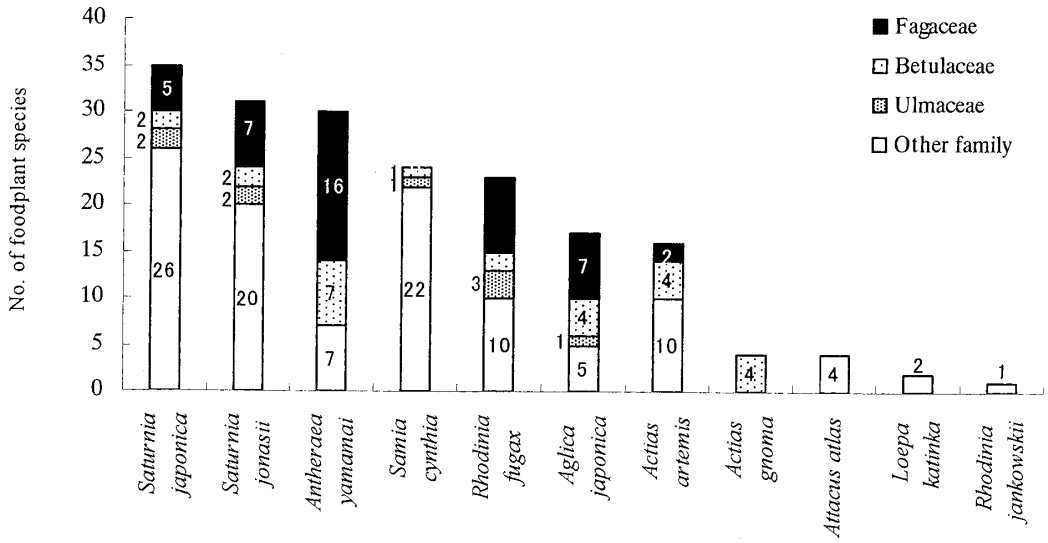


2



3



4

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This species is univoltine, and the adults emerge in early spring in Japan. While these species are polyphagous, one last instar larva was found on *Q. serrata* in Kyoto Prefecture in this study.

B. Summarized list of foodplants in the literature and this study

Forty seven foodplant species of saturniid moths were found in this study. Five species of saturniid moth were found on *Q. serrata* and *C. tschonoskii*. These two foodplants were utilized most frequently by Saturniidae. *A. yamamai* was found on several Fagaceae plants (Table 1). *C. tschonoskii* is a new foodplant that was utilized by five species of Saturniidae: *A. yamamai*, *S. jonasii*, *S. japonica*, *R. fugax*, *A. artemis* and *A. japonica*. *S. jonasii* and *R. fugax* utilized *Q. philyraeoides*, which was recorded as a new foodplant in this study. *R. fugax* was found on three new foodplant species: *Salix chaenomeloides*, *S. subfragilis* and *Benthamidia florida*. *S. jonasii* utilized five new foodplants: *Lindera umbellata* var. *membranacea* (Lauraceae), *Ilex rotunda* (Aquifoliaceae), *Swida macrophylla* (Cornaceae), *Lyonia ovalifolia* (Ericaceae) and *Styrax japonica* (Styracaceae) (Table 2).

C. Relationship between saturniid moths and morphological properties of the foodplants

Among species of Saturniidae, which utilize more than 20 foodplant species, about 38% of the foodplant species used by *S. cynthia* were trees with pinnate compound leaves, but other species of Saturniidae did not predominantly utilize this type of tree. *A. yamamai* did not utilize any of the trees with pinnate compound leaves used by *S. cynthia* (χ^2=13.50, 1 d.f., P<0.001). *Saturnia japonica* utilized five species with pinnate compound leaves (about 14%) (Fig. 2). Most saturniid species utilized deciduous trees, but *A. yamamai* utilized evergreen trees for foodplants more than *S. japonica* (χ^2=9.14, 1 d.f., P<0.005) (Fig. 3). *A. yamamai* utilized Fagaceae more than other Saturniidae (about 52%) (Fig. 4).

D. Cluster analysis of foodplants and similarities of Ochiai index

Phenograms constructed with the UPGMA clustering algorithm using Euclidean distances were chosen for presentation (Fig. 5: foodplant species, Fig. 6: foodplant family). This algorithm shows that the Euclidean of *S. japonica* is remotest, and the distance of the species having narrow geographic distributions, *Attacus atlas*, *Loepa katinka* and *R. jankowskii*, are short (Fig. 5), while the analysis of foodplant families of saturniid larvae revealed that the distance of *S. cynthia* is the remotest (Fig. 6).

As shown in Table 3, the foodplant species of *S. jonasii* and *R. fugax* are most similar among the species of saturniid moth (*OI*=0.524). *S. cynthia* showed little resemblance to other saturniid moths (*OI*≤0.242). *A. yamamai* is somewhat similar to *R. fugax* (*OI*=0.381) and *A. japonica* (*OI*=0.399). The similarity of foodplant family of *R. fugax* and *A. japonica* is highest among the species of saturniid moths (*OI*=0.668)(Table 4).

Discussion

In the present investigation, we discovered 44 foodplant species from 19 families that are utilized by eight species of saturniid moth. All saturniid larvae feed on leaves of various broadleaf trees and the larvae are primarily oak feeders (Inoue, 1982; Teramoto, 1993, 1996, 1998) (Figs 2 and 4). It is reported that some polyphagous lepidopterous larvae uti-

Figs 2–4. Relationship between saturniid moths and foodplant property. The figure in the bar shows the number of species. 2. Leaf type. 3. Evergreen tree and deciduous tree. 4. Foodplant family.

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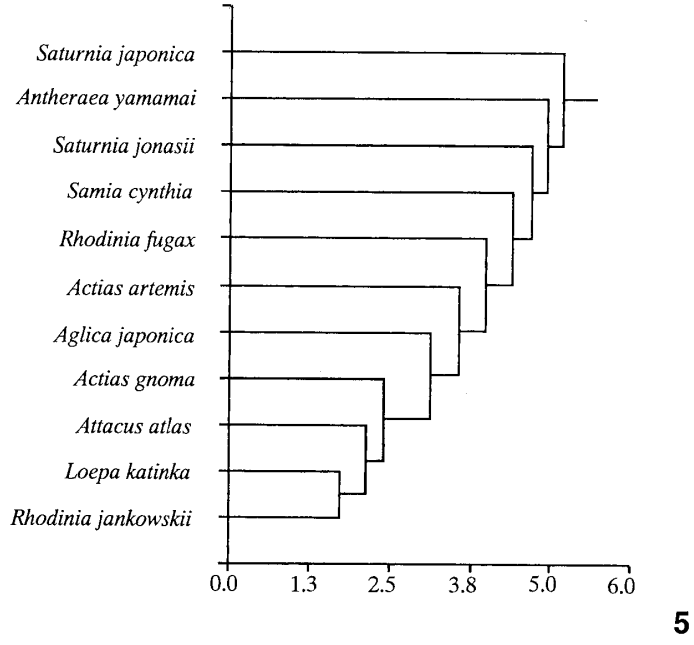

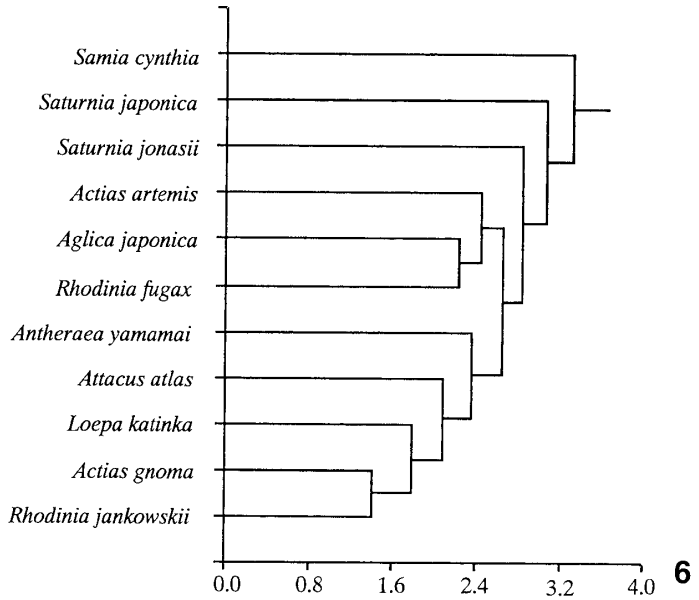

Figs 5–6. Unweighted pair-group method using average (UPGMA) cluster analysis of Euclidean distances derived from the larval foodplant in the Japanese Saturniidae. 5. Foodplant species. 6. Foodplant family.

lizing the leaves of deciduous oak (Fagaceae) also utilize plants related to oak trees, such as *Carpinus* spp. (Teramoto, 1996, 1998). It seems that *Antheraea yamamai* has switched its foodplants from Fagaceae to plants of other families (Teramoto, 2001). We discovered the larvae *A. yamamai*, *Saturnia jonasii*, *S. japonica* and *Rhodinia fugax*, feeding on a new foodplant, *C. tschonoskii*, belonging to the family Betulaceae in the field (Table 2). Betulaceae is in the same order as Fagaceae (Tamura, 1974). The larvae of Saturniidae fed on this plant, *C. tschonoskii*, at most study sites. Thus *C. tschonoskii* may be widely used as a foodplant of Saturniidae throughout Japan. Many Lepidopterous insects feed on oak trees (Family of Fagaceae) (Miyata, 1983; Teramoto, 1990). The numbers of species of

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Table 3. Similarities among the foodplants species of saturniid moths (Ochiai index: *OI*).

	No. of foodplant species	*Attacus atlas*	*Samia cynthia*	*Antheraea yamama*	*Saturnia jonasii*	*Saturnia japonica*	*Rhodinia fugax*	*Rhodinia jankowskii*	*Actias gnoma*	*Acias artemis*	*Aglica japonica*
Attacus atlas	**5**										
Samia cynthia	**24**	*c*=1 0.091									
Antheraea yamamai	**30**	*c*=0 0	*c*=2 0.075								
Saturnia jonasii	**31**	*c*=0 0	*c*=5 0.183	*c*=10 0.328							
Saturnia japonica	**35**	*c*=1 0.076	*c*=7 0.242	*c*=10 0.309	*c*=14 0.425						
Rhodinia fugax	**23**	*c*=0 0	*c*=3 0.128	*c*=10 0.381	*c*=14 0.524	*c*=11 0.388					
Rhodinia jankowskii	**1**	*c*=0 0	*c*=1 0.204	*c*=0 0	*c*=0 0	*c*=0 0	*c*=1 0.204				
Actias gnoma	**4**	*c*=0 0	*c*=0 0	*c*=2 0.183	*c*=0 0	*c*=0 0	*c*=1 0.102	*c*=0 0			
Acias artemis	**16**	*c*=0 0	*c*=2 0.102	*c*=5 0.228	*c*=6 0.269	*c*=8 0.338	*c*=5 0.261	*c*=0 0	*c*=2 0.250		
Aglica japonica	**17**	*c*=0 0	*c*=1 0.050	*c*=9 0.399	*c*=9 0.392	*c*=6 0.246	*c*=9 0.455	*c*=0 0	*c*=3 0.364	*c*=4 0.243	
Loepa katinka	**3**	*c*=0 0	*c*=0 0	*c*=0 0	*c*=0 0	*c*=0 0	*c*=0 0	*c*=0 0	*c*=0 0	*c*=0 0	*c*=0 0

c is the number of foodplant species common to both moth species.

Table 4. Similarities among the foodplants family of saturniid moths (Ochiai index: *OI*).

	No. of foodplant species	*Attacus atlas*	*Samia cynthia*	*Antheraea yamama*	*Saturnia jonasii*	*Saturnia japonica*	*Rhodinia fugax*	*Rhodinia jankowskii*	*Actias gnoma*	*Acias artemis*	*Aglica japonica*
Attacus atlas	**4**										
Samia cynthia	**19**	*c*=2 0.229									
Antheraea yamamai	**6**	*c*=0 0	*c*=3 0.281								
Saturnia jonasii	**15**	*c*=1 0	*c*=7 0.415	*c*=4 0.422							
Saturnia japonica	**18**	*c*=2 0.236	*c*=8 0.433	*c*=4 0.385	*c*=9 0.548						
Rhodinia fugax	**8**	*c*=0 0	*c*=5 0.406	*c*=4 0.577	*c*=7 0.639	*c*=7 0.583					
Rhodinia jankowskii	**1**	*c*=0 0	*c*=1	*c*=0 0.229	*c*=0 0	*c*=0 0	*c*=1 0	0.354			
Actias gnoma	**1**	*c*=0 0	*c*=0 0	*c*=1 0.408	*c*=1 0.258	*c*=1 0.236	*c*=1 0.354	*c*=0 0			
Acias artemis	**8**	*c*=0 0	*c*=3 0.243	*c*=3 0.433	*c*=7 0.639	*c*=7 0.583	*c*=5 0.625	*c*=0 0	*c*=1 0.354		
Aglica japonica	**7**	*c*=0 0	*c*=3 0.260	*c*=3 0.463	*c*=6 0.586	*c*=6 0.535	*c*=5 0.668	*c*=0 0	*c*=1 0.378	*c*=4 0.535	
Loepa katinka	**3**	*c*=0 0	*c*=0 0	*c*=0 0	*c*=1 0.149	*c*=1 0.136	*c*=1 0.204	*c*=0 0	*c*=0 0	*c*=1 0.204	*c*=1 0.218

c is the number of foodplant species common to both moth species.

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Lepidoptera larvae feeding on *C. tschonoskii* (16 species) and *C. laxiflora* (14 species) are smaller than those feeding on *Castanea crenata* (83 species), *Quercus serrata* (151 species) and *Q. acutissima* (160 species) (Miyata, 1983). In the Thecline butterflies, food-habit is inferred to have become specialized from oak trees to other trees (Shirôzu, 1961; Oshima, 1981). In similarities using the *Ochiai index* (*OI*) (Natsuhara, 1998) of the foodplant species of saturniid moth, the foodplant species of *S. jonasii* bears the most resemblance to that of *R. fugax* (*OI*=0.524). The foodplant species of *A. yamamai* do not bear much resemblance to those of other species of Saturniidae (*OI*≤0.399). Saturniid moths may avoid the overlap of foodplant with each other (Table 3–4). Therefore, we suggest that the new foodplant, *C. tschonoskii*, discovered in this study represents a "vacant guild" for food (Miyashita and Noda, 2003).

In Amami Island, Nara Pref. and Kyoto Pref., we observed *A. yamamai* populations (full grown larvae) feeding on *Castanopsis sieboldii*. This plant is not suitable for *A. yamamai* in feeding tests, and most larvae did not grow to the last-instar (Teramoto, 2001). In *A. yamamai*, it is known that the species of foodplant vary between population or genealogies (Teramoto, 2001). Thus, we suggest that the *A. yamamai* populations feeding on *C. sieboldii* differ from those feeding on other plants.

Both Actias artemis and *A. gnoma* belong to the same genus. *A. artemis* is polyphagous, feeding on tree leaves of the families Betulaceae, Fagaceae, Rosaceae, Aceraceae and Ericaceae, while *A. gnoma* feeds only on genus *Alunus* trees of the family Betulaceae (Miyata, 1987). *A. selena* distributed over Taiwan is extremely polyphagous (Wang, 1994), and we found *A. gnoma* feeding on *A. japonica* and *A. firma* trees in our observations. We were unable to find *A. gnoma* on *A. sieboldiana* trees, though they are relatively close to *A. japonica* trees. Therefore, *A. gnoma* may utilize a few species of the *Alunus* genus. In the Izu Islands, densely growing *A. sieboldiana* trees are utilized by *A. gnoma* (Miyata, 1987). Therefore, we need to reconfirm whether *A. gnoma* feed on *A. sieboldiana* trees on the mainland of Honshu in the field.

The Gymnosperm tree reported as a foodplant of *S. japonica* is *Ginkgo biloba*, family Ginkgoaceae, and one of the foodplants of *S. cynthia* is the *Trachycarpus fortunei* tree, family Palmae (Miyata, 1983). In North America, a saturniid moth of the genus *Hyalophra* feeds on conifers, such as the larch tree, *Larix laricina* (Tuskes *et al.*, 1996). In the Oriental Region, some species of *Actias* feed on conifer leaves (Robinson *et al.*, 2001). The foodplant species of saturniid moths and the preference of foodplants may be related to the vegetation in each region. We did not find any saturniid larvae that feed on gymnosperm trees in this study (Table 1), so we conlude that the saturniid moths may be well adapted to vegetation in Japanese coppices with trees of Betulaceae and Fagaceae. A Euclidean distance analysis showed that *S. japonica* is remotest, and the distances of the species having a narrow geographic distribution (*Attacus atlas*, *Loepa katinka* and *R. jankowskii*) are short (Fig. 5). The geographic distribution of *S. japonica* is wide, so we suggest that *S. japonica* has changed its foodplants, adjusting to various vegetations. The Euclidean of foodplant family in *S. cynthia* showing wide geographic distribution is remotest (Fig. 6). The number of foodplant families is greatest (19 families) in *S. cynthia*, followed by 17 families in *S. japonica* and 15 families in *S. jonasii*. Gregarious larvae such as the butterfly, *Nymphalis xanthomelas*, which lay an egg mass, may encounter food shortages (Fukuda *et al.*, 1983). Many species of moth, such as *Lymantria dispar* and *Eumeta japonica*, which lay an egg mass, are polyphagous (Hattori, 1965, 1969). It seems these larvae encounter food shortages and shift to other surrounding plant species (Fukuda *et al.*, 1983; Fukuda and Takahashi, 1988). As a result, the larvae may be able to feed on new foodplant species.

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At the Nara Campus of Kinki University, halfway up the coppiced Yata Hills (Nara Pref.), we found that females of *R. fugax* and *A. artemis* deposited their eggs on the walls of school buildings, because they were attracted to the outdoor light (Shiromoto and Sakuratani, 2004). In Yase (Kyoto Pref.), we caught females of *A. yamamai* that had laid their eggs on the cherry tree, *Prunus* × *yedoensis*. Moreover, there are lights near the cherry tree where the eggs were observed in this record, so these females might be attracted to the light and lay their eggs there. Some illustrated books of moths describe the cherry tree, *P. yedoensis* of Rosaceae as a foodplant, but we did not find *A. yamamai* feeding on *P. yedoensis*. *P. yedoensis* might not be utilized by *A. yamamai* in the field. We found eggs and cocoon of *R. fugax* on garden plants such as dogwood, *Benthamidia florida*, in winter 2004. We did not find *R. fugax* laying eggs on *B. florida* after 2004. Some extra-foodplant ovipositions in many species of butterfly have been reported (Usui, 1963; Nagaoka, 1974; Inaizumi, 1979; Aoki, 1989). The female of *R. fugax* may have mistakenly laid eggs on *B. florida* planted adjacent to *P. yedoensis*, which is preferred by *R. fugax*.

With regard to foodplant habits, it appears that the foodplant preference of saturniid moths has become diversified according to the various types of vegetation that occur in their distribution area, and the foodplant resources for which they are competing with other lepidopteran larvae. The foodplant preference of *S. japonica*, which lays an egg mass, may shift to other surrounding plant species in the case of food shortages from overcrowding. It is suggested that the number of foodplant species increases by oviposition on extra-foodplant species, and expands to other plant species that are not typically utilized by saturniid moths (Fukuda and Takahashi, 1988; Osaki and Sato, 1993).

Acknowledgments

We would like to express our cordial thanks to Dr N. Teramoto, Shiga, Mr H. Yoshimoto, Tokyo, Mr F. Ito, Nara, Ms H Yamamoto, Osaka, Mr M. Sakuratani, Miyagi and Mr. S. Sakuratani, Miyagi. Our thanks are also due to Dr T. Sugimoto, Dr E. Yano and Dr I. Kandori and other members of our laboratory for their kind advice and assistance.

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摘　　要

日本産ヤママユガ科数種の餌植物 (城本啓子・櫻谷保之)

1990年から2006年まで各地で野外調査を行った結果, 19科44種の植物が8種のヤママユガ科ガ類 (シンジュサン, ヤママユ, ヒメヤママユ, クスサン, ウスタビガ, オナガミズアオ, オオミズアオ, エゾヨツメ) の餌植物として確認された. 新たな餌植物として, カバノキ科のイヌシデでヤママユ, ヒメヤママユ, クスサン, ウスタビガ, エゾヨツメの幼虫が各地で確認され, ウバメガシではウスタビガとヒメヤママユの幼虫が確認された. また, ウスタビガではヤナギ科2種と植栽種であるハナミズキ, ヒメヤママユではネジキとオオバクロモジ, クロガネモチ, クマノミズキも餌植物として確認された. 最も多くのヤママユガ科ガ類が利用していた餌植物はイヌシデとコナラで5種 (ヤママユ, ヒメヤママユ, クスサン, ウスタビガ, エゾヨツメ), 続いてクリで4種 (ヤママユ, ヒメヤママユ, クスサン, ウスタビガ) の利用があった. また, 日本におけるヤママユガ科ガ類の今回および既知食樹記録とヤママユガ科ガ類の系統の関係についても考察を行った. 餌植物種によるクラスター解析では, 地理的分布の狭いヤママユガ科ガ類3種 (ヨナグニサン, ハグルマヤママユ, クロウスタビガ) の距離は短くなった. すなわち分布の狭い種は餌植種が少なくなっており, 分布の広いシンジュサンは餌植物の科によるクラスター解析では距離が一番長くなった. ヤママユガ科ガ類間の餌植物種の類似度 (Ochiai指数: *OI*) は, 同じ属であるヒメヤママユとクスサンの間ではやや高かったが (*OI*=0.425), 他の種との類似度はあまり高くないことが示された. また, シンジュサンの餌植物種 (24種) の約38% (9種) が羽状複葉を利用しているなど, 植物の葉の形態によって選択している種もあると考えられた. ヤママユガ科ガ類の餌植物種は生息環境の植生や, クスサンのような集団発生する種においては餌植物の枯渇により周囲の植物への移動などにより多様化していったと考えられる. ウスタビガやオオミズアオの雌成虫がライトに誘引された際に, 建物の壁などへの産卵する現象が見られた. このような誤産卵やイヌシデのような他の鱗翅目幼虫があまり利用していない“空きギルド”を利用することなどにより, ヤママユガ科ガ類の餌植物種数はヤママユガ科種間同士の重複をある程度避けながら広がっていったと考えられる.

(Accepted August 18, 2006)

Published by the Lepidopterological Society of Japan,
5-20, Motoyokoyama 2, Hachioji, Tokyo, 192-0063 Japan

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